

Technical Support for the Navajo Photovoltaic Program

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Abstract. In 1999, the Navajo Tribal Utility Authority (NTUA) purchased 100 stand-alone Photovoltaic (PV) power systems for installation at remote homes throughout the Navajo Nation. The 100 systems consist of 640 W PV arrays, 876 Ah battery, 2.4 kVA inverter, battery charge controller, and associated electronics mounted on a self-contained steel skid. The Photovoltaic Systems Assistance Center (PVSAC) at Sandia National Laboratories (SNL) and the Southwest Technology Development Institute (SWTDI) have been assisting the NTUA in all facets of this wide-scale program including: system design evaluation; installer training; field test and evaluation; performance monitoring; and development of maintenance schedules, maintenance procedures and maintenance record forms. To date, the SNL/SWTDI collaboration has trained NTUA electricians in installation and maintenance procedures, and implemented measures that have safeguarded the battery service life for all 100 systems.

INTRODUCTION

The Photovoltaic Systems Assistance Center (PVSAC) at Sandia National Laboratories (SNL) and the Southwest Technology Development Institute (SWTDI) have been assisting the Navajo Tribal Utility Authority (NTUA) in the installation, maintenance, and operation of their remote-home PV program. This technical assistance has been focused on the NTUA electrician-installers with the goals of ensuring properly installed, maintained, and operated PV systems. To date, the technical assistance has already prevented the premature failure of the batteries of most of the 100 systems and will deliver other benefits as this successful collaboration continues into the future.

serves about 30,900 electric customers, 6,900 natural gas customers, and 25,900 water and sewer customers.

Historically, Navajo People do not live in large communal settlements, but have preferred to live in dispersed, extended family units. Thus, even the most isolated areas of the Navajo Nation have at least some people living on them. Given this situation of "Scattered Site" housing coupled with the mandate of the Navajo Nation Government that NTUA provide utility services to all Navajos, NTUA has long sought cost effective methods of providing electricity to the thousands of Navajo families not living near the utility grid.

THE NAVAJO TRIBAL UTILITY AUTHORITY

The Navajo Nation consists of more than 26,000 square miles of land area, located in the states of Utah, Arizona, and New Mexico. The Navajo Tribal Utility Authority (NTUA) was created in 1959 as an activity of the Navajo Nation to provide modern utility services to the Navajo People. Currently, NTUA

The NTUA and Photovoltaics

NTUA now believes that PV has become a cost-effective technology for serving the Nation's remote inhabitants. With the cooperation of the Department of Energy, Western Area Power Administration, and SNL, the NTUA has begun integrating PV into its utility resource plan and intends to use PV to bring enhancements to the lives of thousands of Navajos without asking them to locate to central housing projects. Equally important, PV power is projected to bring the benefits of modern electric appliances to isolated families in a cost-effective manner.

THE 1999 NTUA PV PROGRAM

In 1999 the NTUA requested bids for 100 stand-alone PV power systems. The contract was awarded to Kyocera Solar, Inc. (then known as Golden Genesis Co.) which delivered 100 'Sun-Pack' solar electrical power systems to the NTUA headquarters in Ft. Defiance, AZ. Specifications for the 'Sun-Pack' systems are shown below in Table 1.

TABLE 1. Kyocera 'Sun-Pack' Power System.

Subsystem	Manufacturer	Number/Type
PV Array	Kyocera	8 KC-80/modules
Battery Bank	Surrette	8 CH375/batteries
Inverter	Trace Engineering	DR2424/mod-square wave
Charge Controller	Lyncom	N35M/PWM controller

The procurement of the 'Sun-Pack' systems was part of a program to provide small amounts of energy to individual families living in very remote areas too far to justify line extension. The units are provided on a lease-to-own agreement for 15 years and NTUA provides all maintenance and replacement during the period of the contract. Qualification for a PV system is based, in part, on the applicant's ability to pay the monthly fee for service required.

SNL and SWTDI Participation

The SNL/SWTDI participation in the program includes the following activities: system design evaluation; installer training; field test and evaluation; performance monitoring; and development of maintenance schedules, maintenance procedures and maintenance record forms. An outline of each these activities is presented below.

System Design Evaluation

SWTDI engineers evaluated the packaged PV systems for overall design and NEC compliance. The evaluation found a few, minor code violations and a few areas where minor modifications in design would result in increased safety or reliability. These results were summarized in a report that was sent to NTUA and to Kyocera for design improvements.

Installer Training

SNL and SWTDI staff provided a workshop for the NTUA electricians designated to install and maintain the PV systems. This two-day workshop covered following: an introduction to PV basics; in-depth discussion of all of the subsystems of the Kyocera 'Sun-Pack'; and techniques for test and repair of all major subsystems. Over 30 NTUA electricians attended the workshop. For many, it was their first exposure to PV and PV systems.

Field Testing

The SNL/SWTDI support included field tests for a selected sample of five installed systems. These tests were conducted after the systems had undergone 90 days of operation.

The 90-day field tests revealed a few common, minor problems. These can be categorized as either problems related to improper installation, or improper operation. The problems associated with installation mistakes included not properly watering the batteries, improper torque on battery cable connections, improper setting of inverter controls, and improper grounding. The operational problems included blown fuses and over-use of the system by the homeowners (resulting in excessively discharged batteries).

System Monitoring

As part of its overall support to NTUA, SWTDI staff designed a low-cost monitor and datalogging instrument. Ten of these were built and installed. These instruments measure and record the following parameters: battery voltage, battery current, battery temperature, and PV current. From these data, the site load current is calculated.

The monitors serve the program in two valuable ways. First, they have already been used to help troubleshoot problems in the field based on real-time readings. Second, over time, the datalogging function will provide a record of how the systems are used and operated. These data records will help assess effects of system use on battery and other subsystem lifetime.

Development of Maintenance Schedules, Procedures, Forms

NTUA asked for assistance in developing a program of regular maintenance for the PV systems.

SNL/SWTDI developed a recommended maintenance schedule and associated procedures. The schedule includes a mandatory 3 visits per year and describes the tests and measurements the electricians should perform during each site visit to determine system health. Repair procedures are also described.

Associated with the maintenance schedule developed by SNL/SWTDI, was a maintenance form. This form serves not only for NUTA requirements for record keeping and billing but also produces the necessary information needed to support the NCPV/SNL off-grid-PV system database. This database is being developed at SNL to document and assess the lifetimes and maintenance requirements of both on and off grid PV systems.

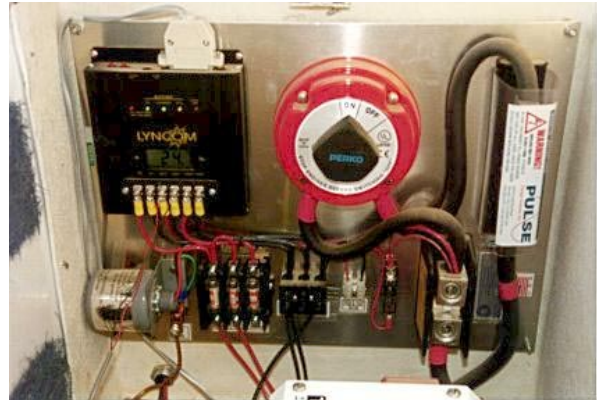


FIGURE 3. 'Sun-Pack' dc wiring panel.

PICTURES FROM THE FIELD



FIGURE 1. SNL/SWTDI engineers performing field test.



FIGURE 2. Interior of 'Sun-Pack' battery box.

SUMMARY

The Photovoltaic Systems Assistance Center (PVSAC) at Sandia National Laboratories (SNL) and the Southwest Technology Development Institute (SWTDI) have been assisting the Navajo Tribal Utility Authority (NTUA) in the installation, maintenance, and operation of their remote-home PV program. Support for the NTUA program has included: system design evaluation; installer training; field test and evaluation; performance monitoring; and development of maintenance schedules, maintenance procedures and maintenance record forms. This technical assistance has been focused on the NTUA electrician-installers with the goals of ensuring properly installed, maintained, and operated PV systems.

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